

MY MICROSCOPE



A QUEKETT CLUB-MAN

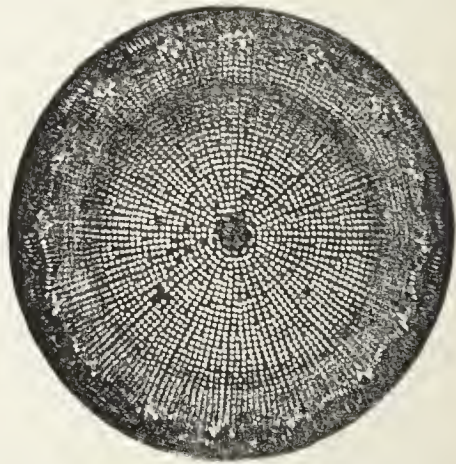
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Aulacodiscus Orientalis.

From a Photo-Micrograph by Mr. T. Charters White.

MY MICROSCOPE

AND

Some Objects from my Cabinet.

*A SIMPLE INTRODUCTION TO THE STUDY
OF 'THE INFINITELY LITTLE.'*

BY

A QUEKETT CLUB-MAN.

T. Channing White

SECOND EDITION, REVISED AND ENLARGED.

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1888.

Dedicated

TO THE

PRESIDENT AND MY FELLOW-MEMBERS

OF THE

QUEKETT MICROSCOPICAL CLUB,

IN GRATEFUL MEMORY OF

MANY PLEASANT EVENINGS PASSED IN THE

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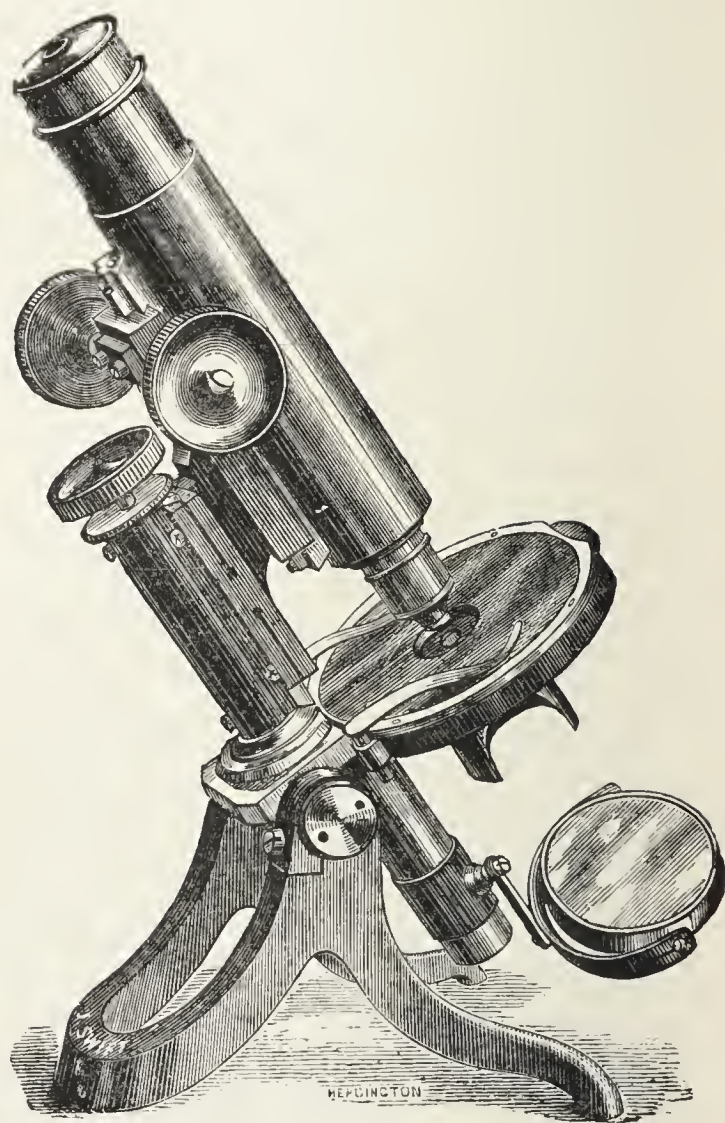


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THE INSTRUMENT.





THE INSTRUMENT.

IT has been a matter of surprise to me when I have been enjoying the pleasure of showing ‘something under the microscope’ to a sympathetic public at a *conversazione*, or similar well-meant recreative assembly, to find how very large a proportion of them have never looked down a microscope worthy of the name, and to learn how very faint and feeble an idea they have of what they should see, and of the actual sizes of the objects presented to them. Under these circumstances it was also impossible to expect them to have any knowledge of the construction of the instrument, and of the aim and uses of its various parts.

In the following pages I propose, therefore,

to take the reader with me, under the supposition that he is under much the same cloud of innocence on the subject, and to show him one of my microscopes, and a few objects from my cabinet, giving him the benefit of what experience I have acquired, and explaining, so far as may be, in unscientific language, the rudiments of 'microscopy.'

My microscope is what is called a portable one, and is monocular; that is, has but one tube, and is used by only one eye at a time. It has a tripod stand, which is perfectly steady in any position, with the usual gauge fitting for accessories under the circular glass stage, three eye-pieces of varying powers (the two higher ones I rarely use), and several object glasses, say 2 inches, magnifying 20 diameters; 1 inch, 50 diameters; $\frac{1}{2}$ inch, 100 diameters: and $\frac{1}{4}$ inch, 250 diameters. To these, when necessary, I can add a $\frac{1}{8}$ water immersion lens, which will give an amplification of 480 diameters—all calculated as used with the lowest eye-piece.

The mirror on its double-jointed arm will give us plenty of light in our field of view for all transparent objects as seen with powers up to the $\frac{1}{2}$ inch, but for higher ones some little help is often required; and here my advice to the tyro who intends to purchase an instrument is to do as I have when obtaining this one, and buy a 'spot lens' of wide angle. This little piece of apparatus will not merely provide him a good black ground with his low powers, but will, when using the $\frac{1}{4}$ or $\frac{1}{8}$ inch, act as a condenser, and give him not only a well-lit field, but also oblique light for resolution of test objects, with a little practice, which is as necessary in this department of science as in any other.

So much for our optical means. The accessories are few and simple. A small bull's-eye condenser for illuminating opaque objects; a polariscope; a live box; a live trough, with glass sides for showing pond life, and a few glass slips and wooden slides will complete our equipment.

Such an instrument as I am showing you

should cost (without the $\frac{1}{8}$ th) not much more than £10, with object-glasses of the best quality, and I would here warn any reader who may be tempted to take up the pursuit, never to buy any microscope without the advice of a competent and experienced friend. The lowest priced article is usually far and away the dearest in the end, and a knowledge of what can be ultimately expended on the instrument should govern the primary selection, as it need hardly be remarked, a good stand can be added to almost *ad libitum*, while a worthless one is only fit for the auction room, and usually finds its way there.

It is necessary that great care be taken of the microscope. For instance we should never put it away without dusting it, as Izaak Walton would probably say, 'as if we loved it,' and indeed we shall do so. No pursuit seems to exercise a greater charm over its votaries; no occupation makes its followers more careless of time or trouble; and this charm renders the microscopist a friend to

his instrument, which is such a never-failing ally, and his devotion will be manifest in the brightness of his brass, the clearness of his glass, the neatness and order of his arrangements, and above all, in his readiness to impart to his less well-informed acquaintance the knowledge that he has acquired by his use of the most complete, the most charming, and the most ever-accessible of the scientific instruments at our disposal.



A VEGETABLE PARASITE.



Cluster Cups.



A VEGETABLE PARASITE.

WE may pleasantly commence our investigations into the minute with a walk in search of 'an object.' Should we live in the country, or even in the further suburbs of town, and the time be the month of May, we will proceed as far as the first broad ditch, tiny streamlet, or even canal bank, which so often has a hedge and ditch on the other side of the towing-path, and look out for the broad leaves of the dock or sorrel (almost any species of *Rumex*). If we are fortunate, it will not be very long before we notice a plant on some of the leaves of which a bright purple spot shows itself on the upper surface. We will at any rate pluck it, as the dock is not a rare plant, and we have no fear

of being accessory to its possible extinction. The pocket lens which I always carry will probably show us, on the reverse of the leaf, precisely under the purple blot, that the little white cluster there is a group of the beautiful fungus called *Æcidium Rubellum*. Taking a few more leaves, if we can find them, so as to be sure of having a perfect specimen, we will put them between the leaves of a pocket-book, or in an old letter, to keep them flat, and return to our microscope.

Securing the portion of the leaf containing the white cluster to a wooden slide, we will use our lowest power eye-piece, the 1-inch objective, and throw a bright ray of light on the object with the bull's-eye condenser. The sight that now presents itself is worth looking at and worth study.

A cluster of most beautiful white cups, the margin of each being of a more delicate network than the most superb lace, each cup, brimful of minute yellowish-white spores, being seated on a purplish base, in

striking contrast to the green of the surrounding portion of the leaf.

We may take this specimen of *Æcidium Rubellum* as typical of a large number of similar *Æcidiacei* which make their homes on, and their living out of, the leaves of plants of a higher order than themselves. Before we note the names of a few other genera and species of leaf fungi, we will learn a little about this one. One of the greatest living authorities on this subject is, no doubt, Dr. Cooke, and he tells us that he has counted the spores in a single cup of a kindred fungus, and finds that they numbered some 250,000, and he says, moreover, that each spore is possibly capable of reproducing its species. No doubt it is; the wonderful economy of nature knows no such trammels as our partial knowledge would impose on it, and the close students of such matters have now arrived at the conclusion that the charming form we have under notice is but one phase in the life history of the same plant, which has hitherto been known under

different designations, even of genera. It may be so, but into such speculations we need not enter, and they would be even foreign to our purpose, which is simply to see and understand certain specimen articles, if we may venture on the term, from nature's manufactory.

We will notice that the purple spot on the leaf is caused by the parasite having exhausted the chlorophyll in its neighbourhood; the final result would, of course, be the destruction of the leaf. This one we have saved from such an end, and can as easily as possible dry it perfectly between blotting-paper and mount it as a permanent object for the cabinet.

We may regard this *Æcidium* as the representative of a multitude of plant parasites, which rejoice in a great variety of learned names, such as *Puccinia*, *Ræstelia*, *Peridermium*, *Endophyllum*, *Coleosporium*, etc., etc. All are beautiful, many rare, and a few obtainable almost anywhere but in the street; wherever there is wood, leaf, water, or hedge,

there some member of this family may be found in its season, by the patient searcher who knows 'how to look,' for the art of finding is not to be acquired in the course of an afternoon's outing in the country.

As the *Æcidium* is one of the most beautiful forms of parasitic fungi, we will observe that species may be found under or upon the leaves of many of our more frequent wild flowers, such as the violet, the nettle, the buttercup, the dandelion, the anemone, and the coltsfoot; all of these, and many others, I have myself collected—the rarer species on the British list would take a lifetime to discover, but a few mounted slides will enrich any cabinet, and give its owner the pleasure of at any time surprising his friends with an insight into an object which has, doubtless, been on many occasions 'so near to, and yet so far from,' each of them.



A SKELETON.



Group of Diatoms, as seen under a half-inch object-glass
with the spot lens.



A SKELETON.

(See *Frontispiece*.)

AND now I will ask the courteous reader to place his eye with mine over the tube of science, and look at a specimen or two of a different class of nature's marvels. We will, still using the lowest power eye-piece, which is the handiest and the truest in nine cases out of ten, put on the $\frac{1}{4}$ -inch objective, and place under it this slide which is labelled *Aulacodiscus Orientalis*. If we are fortunate enough to be working during a bright, sunshiny morning, we shall want no artificial help under the stage, but should the sky be at all leaden in hue, we can simply insert our spot lens in the fitting, and a little clever adjustment will illuminate our field of view admirably.

There it is, and perhaps not one person in a million, not a microscopist, would be likely to guess correctly its origin; a little disc, sculptured and fretted with marvellous workmanship, with ornamentation more elaborate and more beautiful than that of any rose window in the finest Continental cathedral, and yet reminding us in many ways of the window in its general aspect. What is it, and what is its real size? Well, it is the flinty skeleton of a minute salt-water plant, it belongs to the group of low life called Diatomaceæ, and its genus and species we have already noticed on the label; no species of this genus are found in Britain, and as the tiny atom is practically indestructible, this very individual may possibly have tenanted the earth about the time of Abraham—who shall say? At any rate it is quite certain that it may well be in existence for another 4,000 years, for any mutability which is in itself. As for its size, we find, on measuring it, that its diameter is $\frac{1}{66}$ of an inch, so that some 60 of them could be easily ranged in

that space with an interval between each: surely we shall have to seek far for a more wonderful example of the *multum in parvo*, and for a nobler specimen of His handiwork Who not only made the heavens, but moulds a dewdrop. And yet, a somewhat irreverent friend of mine, to whom I was showing a similar object, exclaimed, ‘What a waste of beautiful work, for the chances must have been a million to one that no one ever saw it!’ This is a thought that sometimes occurs to the meditative student of the minute, and you and I will certainly agree that the fact of those perfectly beautiful markings and fashionings tells us that we have an infinity to learn. Without doubt they were not made primarily for the delectation of our eyesight. That each line of silex, that each exquisite boss on the surface of the disc, has its function and plays its part in the life economy of the plant, no student of nature will hesitate to affirm; but what that part is and how it is performed, is a mystery, which has not yet been unveiled, and may possibly be hidden

for ever, even from such inquisitive and eager eyes as yours and mine.

We have only had time to examine one species of diatom, but their forms, appearance, and names are legion. Amongst other genera are some called *Navicula*, or boat-shaped diatoms; *Coscinodiscus* and *Arachnoidiscus*, circular-shaped; and *Pleurosigma*, which resemble a letter S of slight and varying degrees of curvature. This latter genus has many species, and has been used very largely as 'test objects' by which to estimate the quality of object-glasses. Of their suitability for this purpose we will not chat. When doctors disagree, who shall decide? The great guns of the microscopical world differ on the question as the poles from the antipodes, so that you and I will merely look at the 'dots' on the *Pleurosigma Angulatum*, and after reading that they are $\frac{1}{52000}$ of an inch apart, verify the statement, if our skill and optical means allow us. At any rate, we shall by this time have had ample opportunity for wonder at 'the infinitely little,' as shown

in this one small specimen of the contents of a very modest cabinet. Diatoms are to be found in almost every pool, whether of fresh or salt water, and dozens of interesting varieties must be within reach of nearly everyone who lives in the neighbourhood of stream or sea.



A MONSTER.



Hydra vulgaris, with incipient young one.



A MONSTER.

THE animal world is not without a very fair representation in the minutiae of nature. Among the most striking objects which I have been able to exhibit in public have always been living examples of the invertebrate families which inhabit water; they tell so much of their own story, even to the most superficial observer, and carry such an air of real life in their every motion, that one cannot do otherwise than feel the fascination exerted by the movements of a little animal whose size just enables us to recognise its presence with the unaided eye, but whose instincts and evidently voluntary manœuvres are, to all intents and purposes, as important to itself and to its neighbours

as are those of the crocodile or the cuttlefish.

If our lines were cast in such a pleasant place as a country spot, near to which might be found ponds or extensive ditches, we should have but little difficulty in obtaining for ourselves, in the summer, a fine example of the object which I will select as a symbol of the family of the polyps; but living, as so many of us are compelled, in that maze of bricks and mortar called emphatically 'town,' the time necessary for the search for such a treasure is not always available, so we will send to one of those obliging gentlemen who advertise in the scientific papers, and he will forward us, at any given date, to our order (as the commercial folk say), a specimen which shall be guaranteed lively and healthy.

It arrives, and with a view to providing it with the needful rest after its journey, we empty the little tube of all its contents into our 'live trough,' and after a few hours place it bodily on the stage of the microscope.

After possibly a few minutes' search under the 2-inch object-glass, over what now appears a miniature Atlantic Ocean, we come across a leaf, very likely of *Anacharis*, to which is suspended, and apparently glued, a *Hydra*, whose body is a kind of stalk covered with tubercles, and which possesses from three to seven arms, also duly provided with the said tubercles. These arms are continually on the move, searching hither and thither for what they may devour.

Amongst the contents of the postal tube may very likely be other forms of low animal life, and in this case we may be so fortunate as to observe our *Hydra* in the act of seizing on a prey.

We shall notice that the arms rapidly encircle any object coming within reach of their ferocious owner, and should it be suitable for its dinner, it is closely embraced, paralysed, and finally absorbed in the mouth of the animal, which is situated between the arms. A $\frac{1}{2}$ -inch power on our instrument will reveal to us the fact that amongst the

tubercles will be found a sort of dart or stinging organ, which the animal carries in the novel quiver of its own skin. From noticing the presence of the 'darts' in bodies on which it has fed, many naturalists have concluded that it can shoot them at pleasure. We will not enter into this matter, but enjoy the pleasure of a sight of the miniature octopus, which, under favourable conditions, can be preserved alive for many days.

Perhaps after the lapse of a few hours we may find that our little friend has deserted his leaf; in which case nothing is more likely than that he is on the surface of the water, suspended straight down, with the air contained in the sucker at the base of his body utilised as a float, or he may have taken up new quarters on the side of the trough, and from either position it will be easy to pursue his wonderfully sensible evolutions and note the curiously real character of his passion for prey.

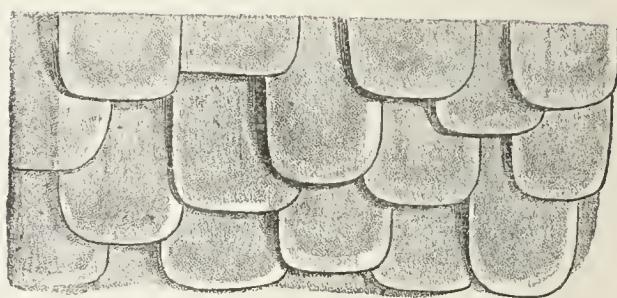
These creatures are usually multiplied by what is termed 'budding;' that is, an ex-

crescence appears on the body, which gradually grows until it develops a new and perfect *Hydra*, which, so soon as it feels itself able to cope with the troubles and responsibilities of independent existence, forthwith separates from its parent stalk, and begins the world on its own account.

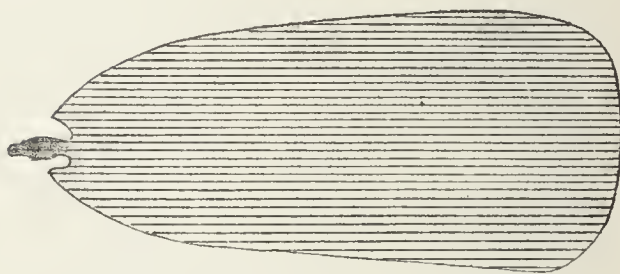
Such an interesting little animal is a fair specimen of its congeners; there are many British freshwater species—among which may be named *Hydra vulgaris*, *H. viridis*, and *H. fusca*—all presenting much the same characteristics, but varying in size and colour. It is possible to permanently mount this polyp, and so have a specimen always at hand to show; but in this case the charm of vitality is of course absent, and the mummy is but a faint image of the Egyptian king.



A WING.



Arrangement of Scales of Butterfly.



Single Scale, highly magnified.



A WING.

WE will now look at an object labelled 'Wing of *Morpho Cipris*.' It is but a portion of the comparatively vast expanse of pinion of this gorgeous exotic butterfly, and to the naked eye resembles a little bit of the 'shot' silk which a few years since was such a favourite fabric with the fair section of our kind.

Put on the 2-inch objective, throw light upon the object with the bull's-eye condenser, and look down the microscope. Tier upon tier of delicate and perfect plumules exhibit themselves, reminding one of the tiles on a rustic dwelling; at present the colour is a reddish 'sunset,' but keep your eye steady while I revolve the stage, and mark the

result. The 'sunset' hue gives place to a vivid azure, and is again replaced by a delicate pink, changing, in its turn, to almost every possible gradation of tint. This is caused by the varying angles of reflected light by which the object is shown to us.

What occurs in nature? We can well picture to ourselves the beautiful insect in its South American home, hovering over its food plant, and with a wave or two of its broad wings at last settling on a floret. The wings vibrate, as is the wont of all its brethren, and fanning itself, with its clubbed antennæ extended, it presents to its companion's view (as to our 2-inch object-glass, under the above conditions) a blaze of jewels. The 'fanning' in nature produces exactly the same effect as the revolution of our stage does artificially, presenting the wings at various angles to the light.

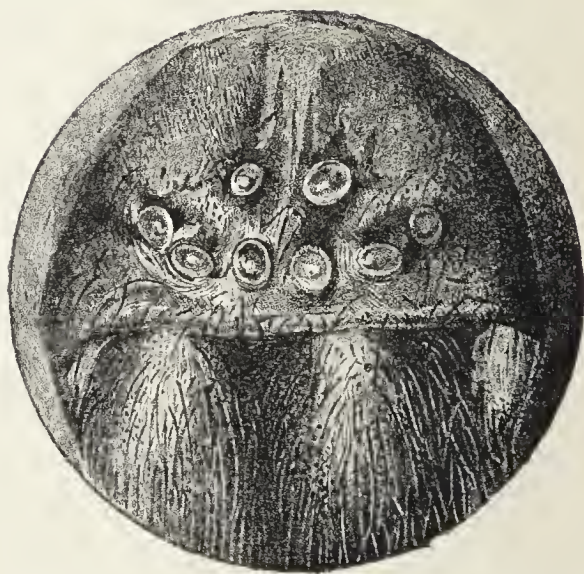
We may well admire such a beautiful provision of nature, and can hardly help envying the fortunate mate, who sees in the

ordinary course of its everyday life such a wealth of colour.

Most of our English *lepidoptera* possess very charming plumage, and will give us many a pleasant and instructive hour if we examine their wings under the microscope. In almost every species the plumules and scales are of different form; many of the scales have been utilised as test objects, and the inspection of the separate plumules as transparent objects under a $\frac{1}{4}$ -inch glass will give us a still closer insight into their form, structure and markings.



AN EYE.



Eyes of a Spider.



AN EYE.

To a casual observer a spider is not usually a very attractive creature, and yet the repulsion generally felt at the sight of one, or even at the mention of its name, is quite unearned by the insect.

There is a very great deal of interest in watching the motions of one of these animals when he is at his ease, and not frightened by our presence. Go into any garden on a summer morning—but choose one when the sun is bright, or, at any rate, when a shower is not falling—and watch one of the commonest of the species—‘*Epeira diadema*.’ There he sits in the centre of his geometric web. Note the marvellous patience with which he waits for a prey; he may get a

victim every hour, or he may be days without a morsel of food; he will put up with whatever his fate may be, and must often suffer the pangs and pains of starvation. But suddenly behind him a fly gets entangled; as by electricity the news is conveyed to him, and with the quickness of thought he turns, darts, and seizes the intruder. A very few minutes suffice for the killing, partial sucking, complete rolling up in silken shroud, and removal out of the way of the lifeless remains.

The eyes of all spiders are eight in number; they are usually mounted on prominences in the head, so as to command a complete view in all directions, and vary in arrangement in different species of the insect. This slide of the eye of a foreign species shows us a capital view of the two front lenses; as we look at it under the inch object-glass we are forcibly reminded of the two lights in front of a locomotive. By lamp-light in the evening the analogy is still more perfect, as the long surrounding hairs with which it is environed suggest the haze

and steam often partially obscuring the front of an engine at night.

We can imagine the feeling of horror overpowering the fly, which must have so much clearer a view of such an object than ourselves, when he sees this fierce set of eyes and dreadful body following intent on his destruction. However, nature compensates in everything; if there were no spiders we might be overwhelmed with flies, and in any case, both spider and fly will provide us with many a charming and interesting object for our cabinet.



A SLICE OF ROCK.



Section of Limestone.



A SLICE OF ROCK.

AT the first blush there is nothing very microscopic about a rock; but it may be well to remember that to the geologist everything that goes to form the crust of the earth comes under that designation, which therefore covers a vast range, from the softest mud to the hardest granite.

This exquisitely prepared section of limestone, which we will take as a good illustration of a rock, will show us that there is a great deal more in a stone than meets the naked eye; indeed, the microscope has done far more service of late years in this department, which is termed Petrology, than in any other, if we except possibly pathology

and the study of disease-germs of various kinds.

Our thin slice of limestone will only require a 2-inch power, at any rate in the first instance, to show us its beauties.

We see that it is composed in great measure of the shells, more or less perfect, of minute animals, which formerly inhabited the ocean; we can identify many of them as having their living representatives, and possibly descendants, now in the wide Atlantic. Most of these shells are those of the lowly order called *foraminifera* (a word literally meaning 'hole-bearers'), from the fact of the house or shell being pierced with wonderfully minute holes through which doubtless its tiny occupant protruded a part of its body in search of food, and also as a means of progression.

These foraminifera are themselves most beautifully perfect microscopic objects, each shell, of a thousand varieties, being as complete and mysteriously beautiful as that of the paper nautilus, or the large ornamental

shells we see so often on the drawing-room 'what-not.' Nature does nothing by halves, though she may work slowly; and her smallest productions are as complete and as well-fitted for their life-work as her most gigantic creations.

The shells, of which the bulk of this stone is composed, are, we notice, bound together by a calcareous cement, which chemically consists of the same elements as the perfect shells, and no doubt is really but the same kind of envelope pounded so small as to be irreconisable—the whole has been welded together to its present state of solidity by the powerful agency of pressure (in some cases, also, fire) with the aid of the water in which it was originally deposited.

The thought has occurred to us above that nature sometimes works slowly; this very stone is an excellent example. It is what is called an organic rock, composed almost exclusively of the remains of animal life of various species, from the large *encrinite* (or sea-lily) to the microscopic foraminifer.

Though very likely it came from a quarry which might be a thousand feet or more in depth, it most certainly, with all its surroundings, formed at one time the bed of the ocean.

And how was it built up? For ages these living denizens of the sea lived, disported themselves, and died; then their remains fell to the bottom, and accumulated there. Here is the origin of all such limestone as we are now considering; then time (and who shall say how long it took?), with the agencies we have above noted, did the rest of the work.

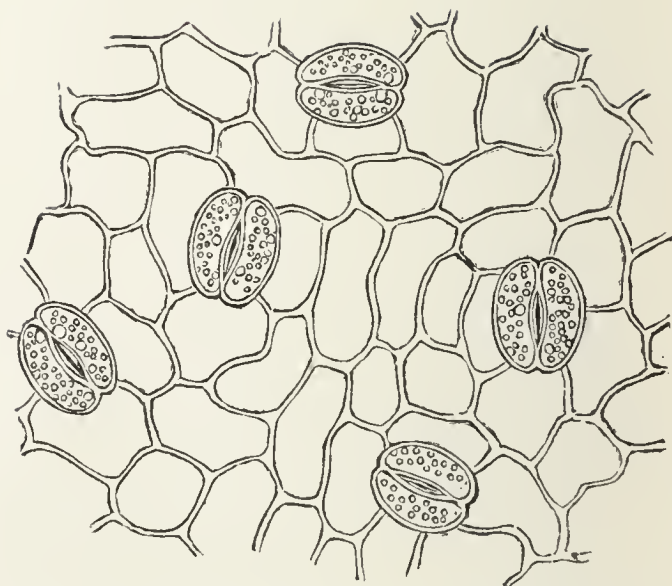
The same process is now going on under our eyes. The bed of the Atlantic, or at least the top layer of that bed, consists of what is called 'Atlantic ooze;' this is just a fluid state of our piece of limestone, and similar forms and varieties of shells may be found in it, only time has not yet been able to compress it to solidity; every instant death is doing its unceasing part in the ocean as on the land, and the dead bodies

and shells of the marine fauna are descending in a continuous shower to the bottom, there to do their part, as everything must in the wonderful order of nature, to rebuild the crust of the earth, from which each has originally taken an infinitesimal portion to clothe itself withal.

In concluding our consideration of a section of limestone, we may bear in mind that chalk is but a more soft variety of the same rock; from it we may often procure, by powdering under water, many beautiful specimens of foraminifera; and that marble, even the whitest and purest, is but the same stone on which that most potent force of nature, heat, has wrought the process of crystallization to such perfection that it is but seldom that any trace is left to us of the organic remains which are so charming and instructive in our 'slice of rock.'



A LEAF.



Outer skin of a leaf, showing its cell structure, and *stomata*.



A LEAF.

FEW natural objects are more readily obtained than leaves, and perhaps it is not too much to say that their structure and functions are as little known to non-scientists as the minutiae of any portion of nature's works.

The illustration shows us the outer portion of the 'skin' of the leaf, technically called the cuticle or *epiderm*, as seen under a $\frac{1}{4}$ -inch object-glass, and displays not only the cells of which the skin is composed, but the remarkable pores or breathing mouths, which are called by botanists *stomata*, and which are the channels by which air is conveyed to the passages which abound in the internal structure of every leaf.

These *stomata* are found in greater or less

abundance in all leaves, more numerous, as a rule, on the under surface of the leaf, and varying in number from a few dozen to many thousands in the space of a square inch.

In the case of leaves which habitually float on the surface of water, these mouths are only found on the upper side of the leaf. The shape of the *stomata* varies in different species of plants, as does also their size; some can therefore be very well seen with a half-inch objective, while others require a good one-eighth to exhibit their structure.

A vertical section across a leaf will give us another view of the *stomata* at its edge, and show us how this opening communicates with the internal portion of the leaf, which is composed of cells containing chlorophyll (leaf-green), which of course is the cause of the colour in the living plant, and certain air-passages, all arranged, as over a skeleton, round the framework formed by the extension of the leaf-stalk through the leaf. It is not very easy for the beginner in microscopical work to make a good section across

a leaf which shall be thin enough to show well the features described, but a leaf can be placed between two pieces of soft cork, and repeated slices across the whole made with a razor, when very likely one or more of the sections of leaf may be thin enough for examination.

Such excellent leaf-sections of every kind may now be obtained from opticians, that unless the observer has much time and more patience at his command, it is hardly worth while to attempt the somewhat difficult art of section-cutting.

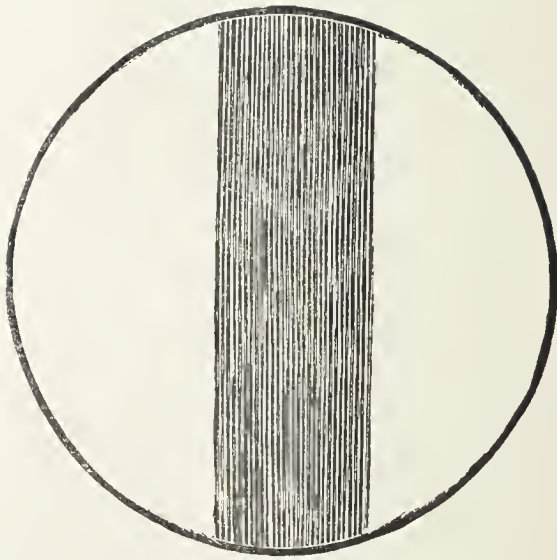
We may note that the colour of nearly all leaves is paler on their under than their upper surface; also that by the aid of their leaves and other green parts plants absorb carbonic acid gas from the atmosphere by daylight, retain the carbon for their own sustenance, and expel the oxygen back into the air.

Nature has thus, we see, most beautifully provided that plants shall not merely delight us in a thousand ways with their shape, their

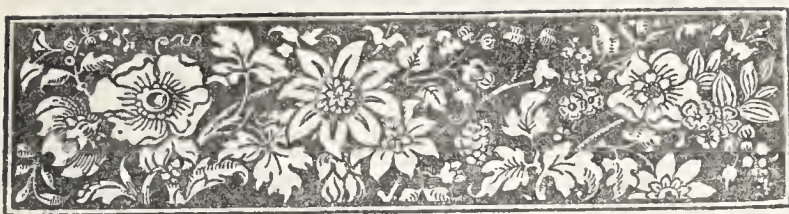
odour, and their colour, but that while doing all this they are acting as scavengers (if we may apply such a term to them) of the atmosphere; and small though the effect of this chemical operation may be in a room or even in a hothouse, yet when we take the whole surface of the globe into consideration, we cannot but be certain that such a provision is a really necessary and important one in the maintenance of the balance of animal and vegetable life.



MAN'S WORK.



The Fifteenth Band of Nobert's Test Plate.



MAN'S WORK.

So far we have, as indeed was only fitting, occupied our attention with natural wonders: they have proved to be so far beyond our untutored expectations, that we cannot suppose the human eye and hand are capable of producing anything so beautiful, or so perfect.

And truly it is so; yet we may make a close to what I would fain hope have been pleasant paths of recreation, by examining an object or two in which man's skill is very evident, although bounteous nature has even here had to provide the materials.

We will select a slide from the cabinet on which at first sight there appears to be nothing at all: if, however, we hold it at a certain angle to the light, we shall see what

seems to be an iridescent scratch. We observe the label; it is 'Nobert's Test Plate.' Touch it, if you please, carefully and reverently, for, apart from its intrinsic value, with which we have small concern, its gifted producer has passed to the Land of light and knowledge, and no more work from his hand will be attainable by us.

On placing this under a $\frac{1}{2}$ -inch object-glass the shadowy line reveals itself as formed of fifteen separate lines—no, not even lines, but groups or series of lines, each set being ruled at a known and certain interval from each other, each being a little closer than its neighbour, and the whole forming the most perfect test for the resolving or dividing power of our object-glasses—the lines on this particular plate run from 11,000 to 90,000 to an inch. We shall see but few of the bands 'resolved' under so low a power as the half-inch, but the one-eighth will, with dexterous management of the spot-lens, show us the whole, or nearly the whole.

The delicate machine with which M.

Nobert accomplished his wonderful rulings has, I understand, passed into the hands of an English amateur. Whether this gentleman can produce equally beautiful work, I cannot say; we will hope so, for the sharpness and crispness of the lines and the precision of their distances far surpass the quality of the rulings on any micrometers I have ever seen, though the latter are merely divided 100 and 1,000 spaces to the inch.

Such an 'object' on the stage of our microscope tells its own tale of the skill and patience necessary for its production. Comment is almost unnecessary, for the angles of the diamond with which it was ruled are but one degree more exquisite, more perfect, and more regular.

An object of another class shall now be placed under the 2-inch objective. It is a marvel of manipulation—a perfect specimen of what patience and perseverance can and do accomplish—a complete flower, leaves, blossoms, and stem all present, and the whole daintily wrought with the scales, the

fairy down, from the wings of various *lepidoptera*. The divers colours are so truly and dexterously chosen that we have no difficulty in identifying the plant as a cineraria. With the unassisted eye the black disk on which this work of art is placed appears to bear on it but a smudge of coloured dust. I think that I never showed this to a friend without hearing expressions of the greatest astonishment, and it is most truly a very wonderful and lovely sight.

I often begin a display of 'popular' objects to admiring neophytes by showing them a micro-photograph. It is so real, and they know so exactly what they ought to see (which latter knowledge is an invaluable acquisition in the use of the instrument) that a sight of a good example never fails to please; and inverting that order of events, we will close this little volume by examination of a slide which simply bears the name, 'A £1,000 note.' Here it is. The little pale brown rectangle has developed itself under the 2-inch glass as a veritable Bank of

England promise to pay the bearer the sum of £1,000. Engraving, and even water-mark in the paper, are all here, and all in perfection, and it is difficult to realize that we are not looking at the precious original.

These are, no doubt, very admirable specimens of human dexterity and ingenuity; but if we are willing to have any possible conceit which their inspection may have engendered completely eradicated, we shall do well to compare, of course under the same power of the microscope in each case, the finest cambric needle we can procure, and the sting of a wasp or bee; also a piece of the most expensive French cambric itself, and the areolations (*ocelli*) on the compound eye of a beetle.

Such contrast will teach us, if aught can, that our powers, by the side of nature's effortless productions, are merely insignificant, and that the wonderful minutiae and perfection of natural objects provides us with an ever-opening vista of enjoyment and admiration.



ONE HUNDRED OBJECTS.



ONE HUNDRED OBJECTS.

THE following suggested list of interesting and instructive objects for examination does not presume to designate itself 'the best hundred objects,' but is one that covers an infinity of ground, and the observer who has learned all that these specimens can teach him will have acquired no inconsiderable insight into 'the infinitely little.'

FUNGI.

<i>Æcidium Ari</i>	on <i>Arum maculatum</i> (orange spores).
„ <i>grossulariæ</i>	„ gooseberry leaves (orange spores).
„ <i>leucospermum</i>	„ wood anemone (white spores).
„ <i>crassum</i>	„ buckthorn (orange spores).
<i>Ræstelia lacerata</i>	„ hawthorn.
<i>Peridermium pini</i>	„ Scotch fir.
<i>Puccinia coronata</i>	„ leaves of fine grass.
„ <i>graminis</i>	„ stalks of corn.

Xenodochus carbonarius, brand on great burnet leaves.

Peronospora infestans, the potato mould (disease).

Peziza bicolor, on the bark of fallen trees.

Coleosporium tussilaginis, on coltsfoot leaves.

Phragmidium bulbosum, brand on bramble leaves.

Uncinula bicornis, maple blight.

Chætomium chartarum, bristle mould on damp paper.

DIATOMS.

Aulacodiscus formosus.

„ *angulatus*.

„ *Petersii*.

„ *Sturtii*.

„ *Solittianus*.

Amphitetras antediluviana.

„ *ornata*.

Arachnoidiscus punctatus.

„ *Ehrenbergii*.

Auliscus sculptus.

„ *racemosus*.

„ *elegans*.

Coscinodiscus excavatus.

„ *elegans*.

Campilodiscus spiralis.

„ *undulatus*.

Eupodiscus argus.

Kittonia elaborata.

Navicula bombus.

„ *maxima*.

„ *lyra*.

„ *strangulata*.

„ *rhomboides*.

Pleurosigma Balticum.

Pleurosigma formosum.
 „ *quadratum.*
Surirella gemma.
Triceratium favus.
 „ *formosum.*
 „ *crenulatum.*

POLYPS, INFUSORIA, POLYZOA, ETC.

Hydra viridis.
Floscularia (many species).
Plumatella repens.
Melicerta ringens, the building rotifer.
Lepralia annulata (marine).
Anguinaria spatulata „
Cellularia avicularia „

PARTS OF INSECTS.

Eye of beetle, transparent.
 Leg of water beetle (*Dityscus marginalis*).
 Eye of gad-fly, opaque.
 Wing of dragon-fly.
 Illuminating organs of glow-worm.
 Tongue of blow-fly.
 „ butterfly.
 Gizzard of cricket.
 Scale of *podura*.
 Battledore scale of *Polyommatus Alexis*.
 Scale from wing of common cabbage butterfly
 Antenna of silkworm moth.
 Hooklets on wing of wasp.
 Antenna of cockchafer.
 Claw of house spider.
 Sting of gnat.

Elytron (wing case) of diamond beetle.
Trachæa (breathing tubes) of silkworm.

PLANT LIFE.

Stomata (pores) in leaf of iris.
 „ „ „ *anacharis*.
 Hairs on lavender leaf.
 Perfume globules of lavender leaf.
 Ovary of vegetable marrow.
Raphides (plant crystals) in leaf of fuchsia.
 „ „ „ cactus.
 Stellate tissue of rush.
 Section of stalk of clematis.
 Cuticle of wheat.
 „ geranium.
 Seed of dandelion.
 „ poppy.
 „ snapdragon.
 „ watercress.
 Pollen of passion-flower.
 „ *lilium auratum*.
 „ hollyhock.
 „ eyebright.
 Peristome of moss (*Funaria hygrometrica*).
 „ „ (*Tortula muralis*).

GEOLOGICAL.

Section of shale, or slate, sedimentary rock.
 „ granite, igneous „
 „ gneiss, „ „
 „ limestone, organic „
 „ dolerite, metamorphic „

POLARISING OBJECTS.

Scale of eel.

„ perch.

Hairs of *Deutzia scabra* (transparent).

Jaw of mole, with teeth *in situ*.

Human gray hair.

Anchors and plates of *Synapta*.



In closing our chats, and taking leave, I would remark that we have but chosen a blossom here and there from the hedge which glitters in the sunlight with a myriad flowers—that we have only seen a stray specimen or two of the marvels of many an obscure world ; even as the dainty glasses in a lady's chamber exhibit but faint evidence of the glories of the conservatory, so has it been with us. Should you, having followed the path thus far, wish to enter more thoroughly into the mysteries of the minute, a happy time awaits you ; nature has hidden wonders at every turn, and each plant, stone, and insect will transform itself into a friend.



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